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Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2014

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A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

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PREP
Piscataqua Region Estuaries Partnership

Introduction

Nitrogen, phosphorus, and sediment loads to the Great Bay Estuary are a constant concern. The Piscataqua Region Estuaries Partnership (PREP) calculates the nitrogen load from tributaries to the Great Bay Estuary for its State of Our Estuaries reports. Therefore, the purpose of this study was to collect representative data on nitrogen, phosphorus, and suspended sediment concentrations in tributaries to the Great Bay Estuary in 2014. The study design followed the tributary sampling design which was implemented by the New Hampshire Department of Environmental Services between 2001 and 2007 and sustained by the University of New Hampshire from 2008 to the present, so as to provide comparable data to the previous loading estimates. The purpose of this memorandum is to document the results of quality assurance checks on the 2014 water quality data collected by UNH, so that PREP can calculates the nitrogen load from tributaries to the Great Bay Estuary. DES reviewed these data to ensure that they met data quality objectives for PREP and for Section 305b water quality assessments.

Methods

Sampling and Analytical Methods

The field sampling and laboratory analysis methods have been documented in the approved Quality Assurance Project Plan (PREP, 2013).

University of New Hampshire researchers collected grab samples from the head-of-tide stations in the freshwater portion of eight tributaries to the Great Bay Estuary (Figure 1) on a monthly frequency from March to December. The samples were analyzed for total dissolved nitrogen (TDN), total nitrogen (TN), total phosphorus (TP), orthophosphate (PO_4), total suspended solids (TSS), ammonia (NH_4), nitrate/nitrite (NO_3/NO_2), total suspended nitrogen (PN), dissolved organic nitrogen (DON), and non-purgeable organic carbon which is equivalent to dissolved organic carbon (DOC). A total of ten field duplicate samples were collected for each parameter (one station per sampling date) for quality assurance.

The Water Quality Analysis Laboratory at the University of New Hampshire used USGS Method I-4650-03 (alkaline persulfate digestion) to determine TN and TP and high temperature catalytic oxidation (Merriam et al., 1996) to determine the TDN concentrations in samples. Suspended solids concentrations were calculated using APHA method 2540-D. Nitrate concentration was determined using EPA method 353.2 and NH_4 using EPA method 350.1. Dissolved organic carbon was determined using EPA method 415.1. Orthophosphate was measured using EPA method 365.1. Dissolved organic nitrogen (DON) was calculated by subtracting nitrate/nitrite and ammonia from TDN.

DOC is not a required parameter in the approved Quality Assurance Project Plan (PREP, 2013). Measurements of DOC were collected as ancillary data. The DOC results were quality assured using the methods and objectives in PREP (2013).

Physico-chemical parameters (water temperature, specific conductance, dissolved oxygen, and pH) were measured in the field using a YSI 556 multi-parameter instrument.

Quality Assurance Audit

UNH provided the field and laboratory data to the New Hampshire Department of Environmental Services to be quality assured and then added to the Environmental Monitoring Database (EMD).

Field sampling proceeded as planned.

- All of the 90 planned samples were collected for laboratory analysis (100%). This meets the data quality objective for completeness (80% of planned samples).

The results of quality control samples for TN, TDN, TP, TSS, PN, NO_3/NO_2, NH_4, DOC, PO_4 and DON have been summarized in Tables 1 through 10. All of the data quality objectives for laboratory results for the study were substantially met. There were no major deviations from the planned laboratory methods.

Field duplicate samples:

- All of the field duplicate samples for DOC, TN, TDN, NO_3/NO_2, DON, PO_4, and the field parameters were within data quality objectives.
- Ammonia: Five of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). Four of the failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. These results were considered acceptable. The duplicate pairs collected in the Bellamy River (station 05-BLM) on 7/23/2014 had an RPD of 53.5% (0.024 and 0.014 mg N/L). Following the guidelines presented in the QAPP, these duplicate pairs were invalidated.
- Total Suspended Nitrogen: Three of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). Two of the failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. These results were considered acceptable. The duplicate pairs collected in the Great Works River (station 02-GWR) on 8/27/2014 had an RPD of 40.4% (0.097 and 0.064 mg N/L). Following the guidelines presented in the QAPP, these duplicate pairs were invalidated.
- Total Phosphorus: Four of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). Two of the failing duplicate pairs were for low concentrations near the detection limit (<10x MDL), which inflate RPD calculations. These results were considered acceptable. The duplicate pairs collected in the Bellamy River (station 05-BLM) on 7/23/2014 had an RPD value of 45.4% (0.013 and 0.020 mg P/L) and the Salmon Falls River (station 05-SFR) on 9/24/2014 had an RPD value of 66.6% (0.025 and 0.013 mg P/L). Following the guidelines presented in the QAPP, these duplicate pairs were invalidated.
- Suspended Sediments: Four of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). However, all of the failing duplicate pairs were for low concentrations (<9 mg/L). Given the natural variability of suspended sediment data, and the relative low concentrations observed, the results were considered acceptable.

Laboratory quality control samples:
The results of laboratory QC tests are shown on Tables 1-10. All of the instances where QC results did not meet data quality objectives were for low concentrations (<10x MDL) or below the detection limit, which is acceptable.

Logical tests:
Laboratory results for nitrogen and phosphorus species were checked to verify that dissolved species were not greater than total species.

- TN vs. TDN: TN should be greater than or equal to TDN. Out of the 90 results for TN and TDN, three results had higher TDN values than TN. For two of the samples TDN was only slightly higher than TN (≤ 3% higher), which was considered acceptable. For the samples collected at station 09-EXT on 04/23/2014 at 10:48, TDN was 18% higher. Discussion with UNH determined that the TN value should be invalidated due to the potential for low bias as a result of suspended solids. UNH has been conducting a two year study on two different methods used to measure TN, as a result of a 2012/2013 USGS memo. The memo indicated that at higher flows and TSS concentrations there is a low bias in the TN-Analytical value vs. a TN-Calculated value. USGS recommends calculating TN by summing TDN and PN, as opposed to directly analyzing for TN. Although UNH's comparison did not show a straightforward bias, they recommend using calculated TN over analytical TN.
- TDN vs. NO_3/NO_2+NH_4: TDN should be greater than or equal to the sum of NO_3/NO_2 and NH_4. Out of 90 samples, zero results had a higher sum of NO_3/NO_2 and NH_4 than TDN.
- TP vs. PO_4: TP should be greater than or equal to PO_4. Out of 90 samples, zero results had a concentration of PO_4 greater than TP.

Results below detection limits:
Several of the results for ammonia (16), total suspended nitrogen (10), total phosphorus (6), orthophosphate (34) and total suspended solids (4) were reported below the reporting detection levels (0.005, 0.025, 0.007, 0.005 and 1 mg/L, respectively). These results are being reported as less than the reporting detection level (<RDL), not the values reported by the laboratory.

Consistency/Comparability:
The range of concentrations measured in 2014 were consistent with previous sampling efforts at these sites (Tables 1-10). Time series plots of the data at different stations were used to identify any unusual results. Unlike previous years, which showed nitrogen concentrations in the Cocheco River were much higher than in other rivers, nitrogen concentrations were relatively similar in all rivers. However, phosphorus concentrations in the Cocheco River were typically higher than in the other rivers.

Results and Discussion

The quality assured results for TN, TP, TDN, TSS, NH_4, NO_3/NO_2, PN, PO_4, DON and DOC concentrations, as well as the field parameters for each station visit are shown in Table 11. Figures 2 through 11 show the monthly concentrations for each analyte at each station.

The purpose of this memorandum is to document the results of quality assurance checks on the 2014 water quality data collected by UNH, so that PREP can calculates the nitrogen load from tributaries to the Great Bay Estuary. The following are some general observations which can be made based on the quality assured data:

- The concentrations of TN at each station ranged from 0.299-2.569 mg N/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC), and was substantially higher than the concentrations at the other stations in 2014. Although the 2.569 mg N/L was elevated, it was still much lower than the maximum value observed in the estuary, which was 4.17 mg N/L. Therefore, the measurement is considered valid. The rest of the data showed TN concentrations between 0.299 and 0.941 mg N/L.

- The concentrations of TP at each station ranged from < 0.007 to 0.255 mg P/L. The maximum concentration consistently occurred in the Cocheco River (station 07-CCH).

- The concentrations of TDN at each station ranged from 0.232 to 0.711 mg/L. The maximum concentrations occurred in the Great Works River (station 02-GWR).

- The TSS concentrations ranged from <1.0 to 36.8 mg/L. The highest average concentration was in the Great Works River (station 02-GWR).

- The concentrations of NO_3/NO_2 at each station ranged from 0.006 to 0.616 mg N/L. The maximum concentrations occurred in the Great Works River (station 02-GWR).

- The average NH_4 concentration ranged from <0.005 to 0.075 mg N/L. The Salmon Falls River had the highest concentration (station 05-SFR).

- The concentrations of DON at each station ranged from 0.083 to 0.516 mg N/L. The maximum concentrations occurred in the Oyster River (station 05-OYS).

- The concentrations of DOC at each station ranged from 3.47 to 9.5 mg C/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC).

- The average concentrations of PO_4 at each station ranged from <0.005 to 0.215 mg P/L. The maximum concentrations occurred primarily in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The only exception was the sample collected in the Oyster River (station 05-OYS) on 5/28/2014. The remaining stations had average PO_4 concentrations between <0.005 and 0.086 mg P/L.

References

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Table 1: Summary of Quality Control Samples for Total Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	8 Lab Duplicates / 0 Failed DQO 8 Lab Replicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 1 Failed DQO 10 LFM tests / 0 Failed DQO The failures was for a sample with a low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TN concentrations in 2014 (0.30-2.57 mg/L) was similar to the range from 2001-2013 (0.11-4.17 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.30 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 2: Summary of Quality Control Samples for Total Dissolved Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 2 Failed DQO 7 LFM tests / 0 Failed DQO The failures were for a samples with a low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TDN concentrations in 2014 (0.23-0.71 mg/L) matched the range from 2008-2013 (0.17-2.92 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.23 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 3: Summary of Quality Control Samples for Total Phosphorus

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 4 Failed DQO 2 of the failures were close to the DQO or were for samples with low concentrations (<10xMDL). The results associated with the remaining failures were invalidated.
Precision-Lab	RPD < 15%	Lab Duplicates	10 Lab Duplicates / 1 Failed DQO 7 Lab Replicates / 0 Failed DQO The failure was for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 2 Failed DQO 11 LFM tests / 0 Failed DQO The failures were for a samples with a low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2014 (<0.007-0.255 mg/L) was similar to the range from 2001-2013 (0.003-0.162 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.007 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 4: Summary of Quality Control Samples for Suspended Solids

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates /4 Failed DQO The failures were for samples with a low concentration
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TSS concentrations in 2014 (<1.0-36.8 mg/L) matched the range from 2001-2013 (0.9-57 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 1.0 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 5: Summary of Quality Control Samples for Total Suspended Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 3 Failed DQO 2 of the failures were close to the DQO or were for samples with low concentrations (<MDL). The results associated with the remaining failure were invalidated.
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	14 CRM tests / 0 Failed DQO **NO DATA** for LFM tests
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of total suspended nitrogen in 2014 (<0.025-0.221 mg/L) was similar to the range from 2013 (0.028-0.225 mg/L)
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.025 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 6: Summary of Quality Control Samples for Nitrate/Nitrite

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 1 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 1 Failed DQO 10 LFM tests / 0 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of nitrate/nitrite concentrations in 2014 (<0.006-0.616 mg/L) was similar to the range from 2009-2013 (0.005-2.52 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.006 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 7: Summary of Quality Control Samples for Ammonia

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 5 Failed DQO 3 of the failures were samples with low concentrations (<10xMDL). The results associated with the remaining failures were invalidated.
Precision-Lab	RPD < 15%	Lab Duplicates	9 Lab Duplicates / 4 Failed DQO The failures were for samples with a low concentration (<10xMDL or BDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	10 CRM tests / 2 Failed DQO 10 LFM tests / 0 Failed DQO The failures were samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of ammonia concentrations in 2014 (<0.005-0.075 mg/L) was similar to the range for 2009-2013 (0.005-0.158 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 8: Summary of Quality Control Samples for Dissolved Organic Carbon

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 1 Failed DQO 7 LFM tests / 0 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of dissolved organic carbon in 2014 (3.47-9.50 mg/L) was similar to the range for 2011-2013 (3.02-15.3 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 3.47 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 9: Summary of Quality Control Samples for Orthophosphate

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 2 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<MDL)
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of orthophosphate in 2014 (<0.005-0.215 mg/L) was similar to the range for 2011-2013 (0.005-0.340 mg/L)
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration above the RDL was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 10: Summary of Quality Control Samples for Dissolved Organic Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<MDL)
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of dissolved organic nitrogen in 2014 (0.083-0.516 mg/L) was similar to the range for 2010-2013 (0.006-0.496 mg/L)
Sensitivity	Not expected to be an issue for this project	NA	Lowest detected concentration was 0.083 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	80 routine samples and 10 field duplicates were collected (100% of planned samples)

Table 11: Validated Laboratory Results and Field Data at Tributary Stations

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
02-GWR	3/26/14	4.47	13.25	92.2	0.941	0.012	0.711	0.616	0.083	0.212	6.57	0.046	< 0.005	36.80	141	0.8
02-GWR	4/23/14	5.10	10.61	95.7	0.371	0.011	0.311	0.086	0.214	0.047	6.75	0.015	0.005	4.00	104	10.8
02-GWR	5/28/14	6.38	7.31	70.8	0.512	0.020	0.316	0.078	0.219	0.049	6.89	0.022	< 0.005	3.46	125	14.0
02-GWR	6/25/14	7.03	7.18	83.9	0.434	< 0.005	0.349	0.086	0.259	0.128	6.90	< 0.007	< 0.005	3.00	119	23.1
02-GWR	7/23/14	7.20	5.58	69.1	0.455	0.005	0.409	0.091	0.313	0.110	7.36	0.030	< 0.005	2.73	131	26.4
02-GWR	8/27/14*	7.52	4.41	47.9	0.507	0.010	0.420	0.107	0.303	**0.064**	6.64	0.021	0.008	15.77	136	22.8
02-GWR	8/27/14	7.52	4.47	52.6	0.546	0.012	0.475	0.107	0.355	**0.097**	7.03	0.018	< 0.005	11.79	136	23.6
02-GWR	9/24/14	4.30	6.86	67.8	0.299	< 0.005	0.260	0.058	0.203	0.026	6.50	0.012	0.006	2.63	145	14.9
02-GWR	10/22/14	7.77	8.52	78.3	0.315	< 0.005	0.232	0.010	0.221	< 0.025	6.14	0.009	< 0.005	6.00	137	11.6
02-GWR	11/24/14	7.48	14.84	104.6	0.556	0.006	0.473	0.112	0.355	0.029	6.63	0.007	< 0.005	< 1	132	1.1
02-GWR	12/17/14	6.95	13.16	96.5	0.501	< 0.005	0.435	0.148	0.286	0.047	6.58	< 0.007	< 0.005	2.29	108	2.5
02-WNC	3/26/14	5.54	13.48	92.3	0.561	0.011	0.505	0.264	0.231	0.034	6.91	0.015	0.006	2.12	324	0.1
02-WNC	4/23/14	6.37	9.80	93.3	0.542	0.011	0.430	0.168	0.251	0.040	6.82	0.023	0.013	2.22	321	13.2
02-WNC	5/28/14*	7.50	8.48	80.0	0.667	0.064	0.541	0.183	0.294	0.067	6.71	0.033	0.006	6.00	397	13.1
02-WNC	5/28/14	7.54	8.08	77.9	0.698	0.063	0.500	0.187	0.250	0.064	6.80	0.029	0.008	5.43	396	13.7
02-WNC	6/25/14	9.25	7.34	84.2	0.577	0.035	0.509	0.100	0.374	0.066	7.13	0.019	0.014	2.50	395	22.2
02-WNC	7/23/14	9.47	5.34	62.6	2.569	0.024	0.510	0.059	0.428	0.066	7.28	0.053	0.008	1.14	423	23.2
02-WNC	8/27/14	9.50	4.19	47.7	0.562	0.032	0.525	0.057	0.437	0.047	7.02	0.041	0.008	2.71	387	21.8
02-WNC	9/24/14	5.65	6.87	68.7	0.433	0.020	0.364	0.060	0.284	0.025	6.90	0.020	< 0.005	3.03	457	15.4
02-WNC	10/22/14	7.19	9.46	86.3	0.529	0.026	0.480	0.046	0.408	0.038	6.34	0.025	0.013	3.33	443	11.2
02-WNC	11/24/14	8.17	14.14	103.6	0.658	0.006	0.602	0.188	0.408	< 0.025	6.65	0.016	0.006	1.84	400	2.5
02-WNC	12/17/14	7.99	11.92	87.4	0.598	0.006	0.582	0.199	0.376	< 0.025	6.78	< 0.007	0.005	2.98	237	2.5
05-BLM	3/26/14	4.58	14.12	100.1	0.508	0.031	0.414	0.233	0.151	0.047	6.86	0.019	0.008	4.57	197	1.3
05-BLM	4/23/14	5.34	10.11	93.3	0.333	0.008	0.263	0.060	0.194	0.045	6.91	< 0.007	< 0.005	3.71	115	11.8
05-BLM	5/28/14	5.64	8.82	84.6	0.442	0.027	0.299	0.065	0.207	0.064	6.62	0.024	0.006	5.83	157	13.5
05-BLM	6/25/14	4.72	8.19	100.0	0.619	0.018	0.483	0.240	0.225	0.137	7.73	0.029	0.005	15.00	284	25.6

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
05-BLM	7/23/14*	5.11	6.66	82.9	0.492	**0.014**	0.382	0.083	0.286	0.067	8.10	**0.020**	0.006	4.00	233	26.9
05-BLM	7/23/14	5.56	6.02	74.6	0.435	**0.024**	0.421	0.089	0.309	0.063	7.82	**0.013**	0.007	4.23	235	26.4
05-BLM	8/27/14	5.31	5.36	67.3	0.527	0.038	0.475	0.108	0.329	0.060	7.23	0.031	0.010	4.67	243	24.6
05-BLM	9/24/14	4.56	8.33	83.0	0.487	0.039	0.458	0.103	0.317	0.055	6.48	0.024	< 0.005	6.25	247	15.2
05-BLM	10/22/14	8.14	9.97	90.3	0.417	0.044	0.419	0.037	0.338	0.027	6.42	0.020	0.007	3.64	300	10.9
05-BLM	11/24/14	6.41	15.57	114.1	0.692	< 0.005	0.542	0.095	0.447	0.027	6.40	< 0.007	< 0.005	< 1	162	2.4
05-BLM	12/17/14	6.97	12.20	90.7	0.541	< 0.005	0.512	0.131	0.377	0.076	6.68	0.017	< 0.005	6.19	164	3.0
05-LMP	3/26/14*	4.04	14.61	99.9	0.392	0.006	0.386	0.207	0.172	0.031	3.34	0.018	0.006	3.59	144	0.0
05-LMP	3/26/14	4.14	13.88	94.8	0.456	0.009	0.405	0.198	0.198	0.038	4.00	0.018	< 0.005	2.49	145	0.0
05-LMP	4/23/14	4.62	11.17	102.2	0.387	0.017	0.301	0.107	0.177	0.045	6.14	0.016	0.012	1.79	127	11.4
05-LMP	5/28/14	5.25	8.47	83.7	0.449	0.024	0.325	0.126	0.174	0.043	6.07	0.112	< 0.005	2.39	150	14.8
05-LMP	6/25/14	4.44	8.77	103.7	0.552	0.005	0.350	0.157	0.188	0.080	7.20	0.007	< 0.005	2.00	165	23.8
05-LMP	7/23/14	7.18	5.59	67.5	0.482	0.027	0.408	0.070	0.310	0.094	7.26	0.031	NA	1.88	147	25.0
05-LMP	8/27/14	7.15	5.04	58.3	0.580	0.009	0.383	0.070	0.304	0.065	6.86	0.015	< 0.005	2.73	130	23.1
05-LMP	9/24/14	5.85	6.31	64.4	0.586	0.005	0.578	0.105	0.469	0.046	6.08	0.022	0.005	4.05	175	16.3
05-LMP	10/22/14	6.65	10.99	103.1	0.481	0.014	0.462	0.095	0.352	0.041	6.29	0.018	0.007	2.55	160	12.5
05-LMP	11/24/14*	6.55	19.94	107.4	0.547	< 0.005	0.533	0.111	0.422	< 0.025	6.44	0.019	< 0.005	4.33	80	1.8
05-LMP	11/24/14	6.15	14.87	107.1	0.498	0.007	0.467	0.116	0.343	0.047	6.57	0.016	< 0.005	3.24	150	1.9
05-LMP	12/17/14	6.62	13.46	96.7	0.492	< 0.005	0.480	0.124	0.355	< 0.025	6.35	0.013	< 0.005	1.00	112	1.8
05-OYS	3/26/14	4.53	14.88	103.1	0.546	0.026	0.498	0.293	0.178	0.035	6.50	0.010	0.007	2.48	227	0.4
05-OYS	4/23/14	4.87	10.41	95.2	0.419	0.036	0.351	0.157	0.159	0.047	6.88	0.028	0.007	2.97	224	11.4
05-OYS	5/28/14	6.28	8.23	79.3	0.596	0.044	0.421	0.128	0.250	0.078	5.90	0.091	0.086	4.48	227	13.7
05-OYS	6/25/14*	5.52	9.53	110.4	0.544	< 0.005	0.312	0.073	0.240	0.100	7.15	0.023	< 0.005	4.57	245	22.8
05-OYS	6/25/14	5.39	10.28	117.7	0.470	< 0.005	0.341	0.058	0.282	0.099	7.12	0.023	< 0.005	4.33	245	22.2
05-OYS	7/23/14	6.43	6.64	77.9	0.521	0.012	0.351	0.021	0.317	0.108	7.18	0.026	0.006	2.22	294	23.7
05-OYS	8/27/14	8.26	6.11	69.0	0.654	0.022	0.501	0.100	0.379	0.092	6.83	0.033	0.007	4.24	218	21.4
05-OYS	9/24/14	6.41	6.91	68.2	0.593	< 0.005	0.528	0.013	0.516	0.152	6.37	0.038	0.006	7.39	347	14.8

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
05-OYS	10/22/14	4.65	8.46	77.7	0.459	0.016	0.422	0.042	0.364	0.126	6.61	0.025	0.009	3.08	396	11.5
05-OYS	11/24/14	7.38	13.44	99.6	0.704	0.016	0.652	0.212	0.424	0.052	6.50	0.012	0.009	1.03	251	2.8
05-OYS	12/17/14	6.85	13.11	96.3	0.724	0.012	0.703	0.290	0.401	0.040	5.79	0.021	< 0.005	3.53	217	2.6
05-SFR	3/26/14	4.33	14.82	102.6	0.470	0.042	0.354	0.200	0.113	0.040	6.72	0.020	< 0.005	3.55	136	0.4
05-SFR	4/23/14	4.13	10.90	97.8	0.542	0.037	0.287	0.097	0.153	0.117	6.64	0.051	< 0.005	18.08	89	10.5
05-SFR	5/28/14	6.36	8.31	81.4	0.486	0.075	0.392	0.119	0.197	0.058	6.67	0.011	< 0.005	2.00	110	14.5
05-SFR	6/25/14	5.45	7.40	91.4	0.463	< 0.005	0.344	0.101	0.242	0.108	7.68	0.014	0.009	2.50	128	26.1
05-SFR	7/23/14	7.66	6.06	76.2	0.777	0.009	0.541	0.244	0.287	0.145	7.43	0.027	0.013	5.88	128	27.1
05-SFR	8/27/14	7.21	4.79	58.4	0.679	0.014	0.591	0.191	0.386	0.157	7.57	0.030	0.008	14.17	126	25.4
05-SFR	9/24/14*	5.40	7.42	77.2	0.689	< 0.005	0.557	0.308	0.246	0.087	6.61	**0.013**	< 0.005	8.80	148	17.3
05-SFR	9/24/14	4.97	7.26	75.5	0.734	0.011	0.515	0.304	0.200	0.086	6.65	**0.025**	< 0.005	3.33	147	17.2
05-SFR	10/22/14	3.66	10.85	102.4	0.512	0.049	0.348	0.137	0.162	0.059	6.70	0.050	0.024	3.93	126	12.8
05-SFR	11/24/14	5.74	14.75	107.8	0.554	0.024	0.516	0.166	0.325	0.026	6.49	0.023	0.021	1.50	109	2.4
05-SFR	12/17/14	5.68	13.40	97.5	0.468	0.017	0.443	0.135	0.290	0.038	6.65	< 0.007	0.005	2.65	99	2.2
07-CCH	3/26/14	3.54	15.11	103.3	0.720	0.034	0.614	0.447	0.132	0.037	6.82	0.027	0.013	2.86	196	0.1
07-CCH	4/23/14	3.96	10.83	98.1	0.602	0.048	0.532	0.333	0.150	0.047	6.63	0.050	0.020	2.12	154	10.9
07-CCH	5/28/14	5.25	8.95	86.7	0.585	0.033	0.466	0.255	0.178	0.073	6.63	0.050	0.021	2.86	157	14.0
07-CCH	6/25/14	3.95	7.73	94.0	0.623	0.007	0.428	0.180	0.241	0.081	7.49	0.061	0.026	1.56	201	25.3
07-CCH	7/23/14	5.90	5.67	70.3	0.591	0.016	0.521	0.232	0.273	0.084	7.28	0.066	0.039	< 1	163	26.4
07-CCH	8/27/14	5.74	4.77	56.6	0.795	0.015	0.628	0.377	0.236	0.056	7.18	0.068	0.028	8.89	191	23.9
07-CCH	9/24/14	3.47	7.63	78.2	0.711	0.008	0.632	0.426	0.198	0.068	6.64	0.106	0.046	3.03	297	16.5
07-CCH	10/22/14*	4.00	12.00	110.1	0.745	0.016	0.661	0.445	0.200	0.040	6.55	0.226	0.215	5.13	332	11.5
07-CCH	10/22/14	3.61	11.68	107.3	0.714	0.007	0.624	0.463	0.153	0.025	6.49	0.255	0.206	4.19	331	11.5
07-CCH	11/24/14	4.38	15.75	114.8	0.524	0.013	0.489	0.220	0.256	< 0.025	6.49	0.043	0.026	< 1	140	2.3
07-CCH	12/17/14	5.41	13.20	95.9	0.560	0.010	0.524	0.237	0.277	< 0.025	6.60	0.014	0.011	2.69	128	2.2
09-EXT	3/26/14	5.09	13.87	94.4	0.389	0.009	0.366	0.176	0.182	0.036	6.67	0.007	< 0.005	3.20	170	0.1
09-EXT	4/23/14*	6.16	9.19	86.8	**0.393**	0.018	0.470	0.089	0.363	0.047	6.58	0.010	0.009	1.64	166	13.0

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	TN (mg N/L)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	TPN (mg N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
09-EXT	4/23/14	5.88	9.55	91.2	0.404	0.016	0.416	0.075	0.325	0.044	6.68	0.015	0.006	1.14	165	13.3
09-EXT	5/28/14	7.11	7.25	71.2	0.507	0.036	0.399	0.109	0.254	0.068	6.36	0.017	< 0.005	6.21	192	14.6
09-EXT	6/25/14	6.48	8.30	98.2	0.653	< 0.005	0.326	0.027	0.297	0.221	7.18	0.036	< 0.005	8.40	193	23.8
09-EXT	7/23/14	7.69	5.63	69.4	0.620	0.012	0.378	0.006	0.360	0.132	7.15	0.018	0.005	4.17	216	25.6
09-EXT	8/27/14	8.36	4.70	54.1	0.503	0.005	0.472	0.012	0.455	0.069	6.69	0.020	0.006	1.43	194	22.4
09-EXT	9/24/14	6.32	5.64	57.7	0.437	0.012	0.356	0.022	0.322	0.047	6.21	0.030	< 0.005	3.26	243	16.4
09-EXT	10/22/14	6.42	6.66	62.0	0.491	0.007	0.457	0.043	0.407	0.073	6.15	0.042	0.033	3.70	238	12.2
09-EXT	11/24/14	7.86	13.93	99.9	0.588	< 0.005	0.542	0.126	0.414	< 0.025	6.37	0.014	< 0.005	1.19	218	1.7
09-EXT	12/17/14*	8.27	12.74	90.7	0.500	0.006	0.483	0.119	0.358	< 0.025	6.26	0.017	0.006	2.00	158	1.5
09-EXT	12/17/14	8.22	13.24	95.1	0.550	< 0.005	0.521	0.123	0.395	< 0.025	6.41	0.008	< 0.005	1.43	159	1.8

* Field duplicate sample

Bold values were invalidated by DES

Figure 1: Sampling locations in the Great Bay Estuary, Coastal Basin

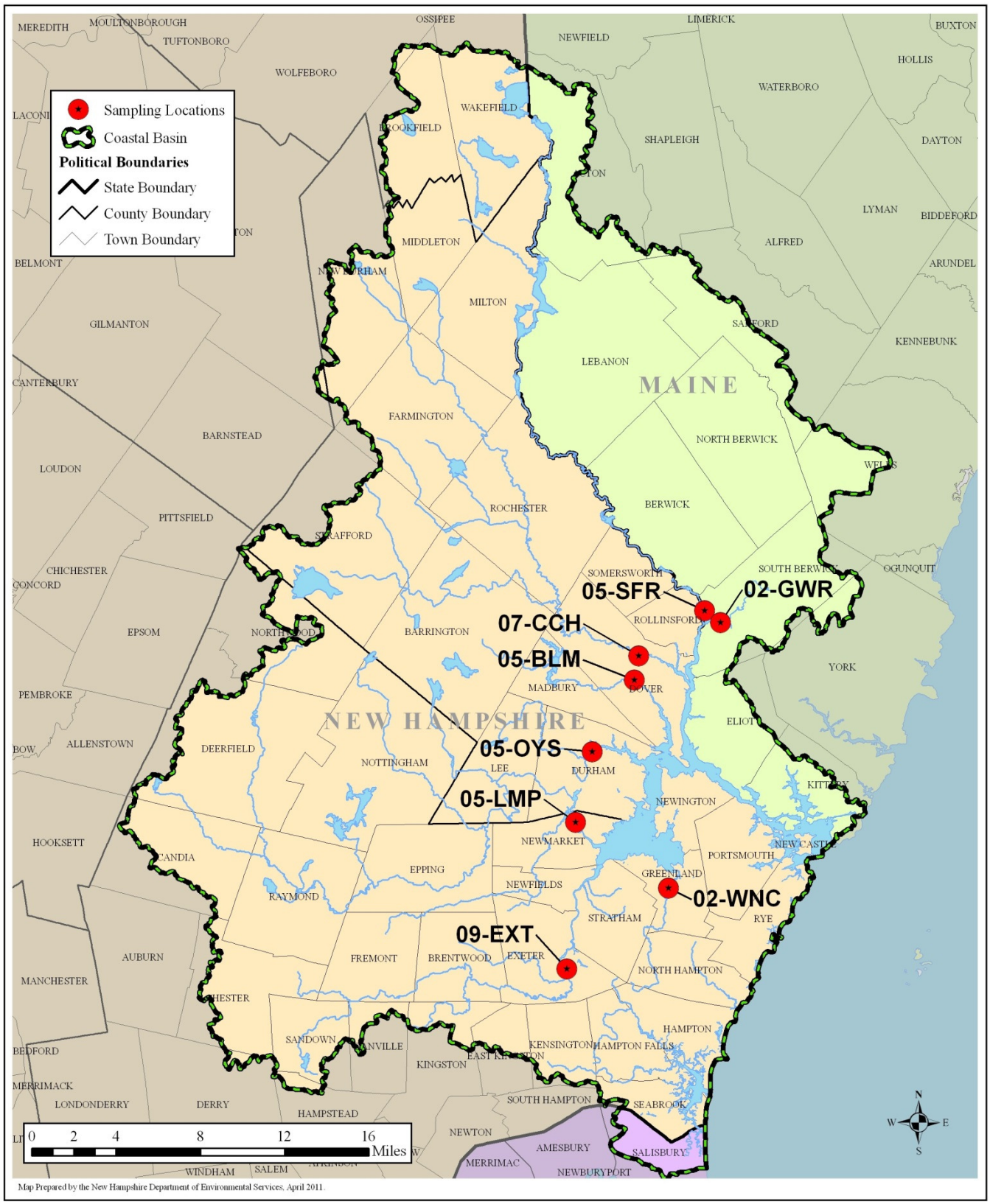

Figure 2: Total Nitrogen Concentrations (in mg N/L) at Tributary Stations

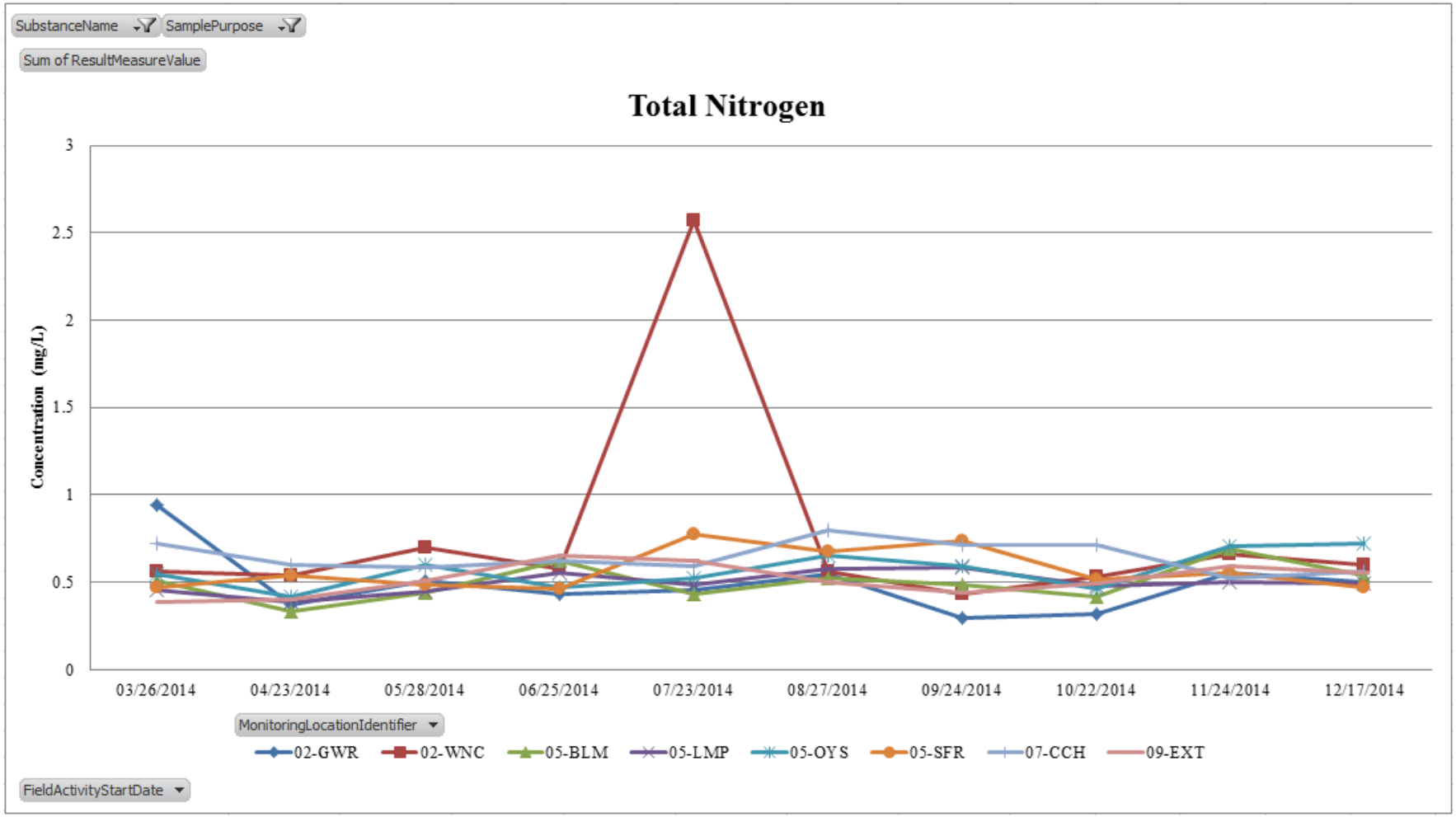

Figure 3: Total Phosphorus in Concentrations (mg P/L) at Tributary Stations

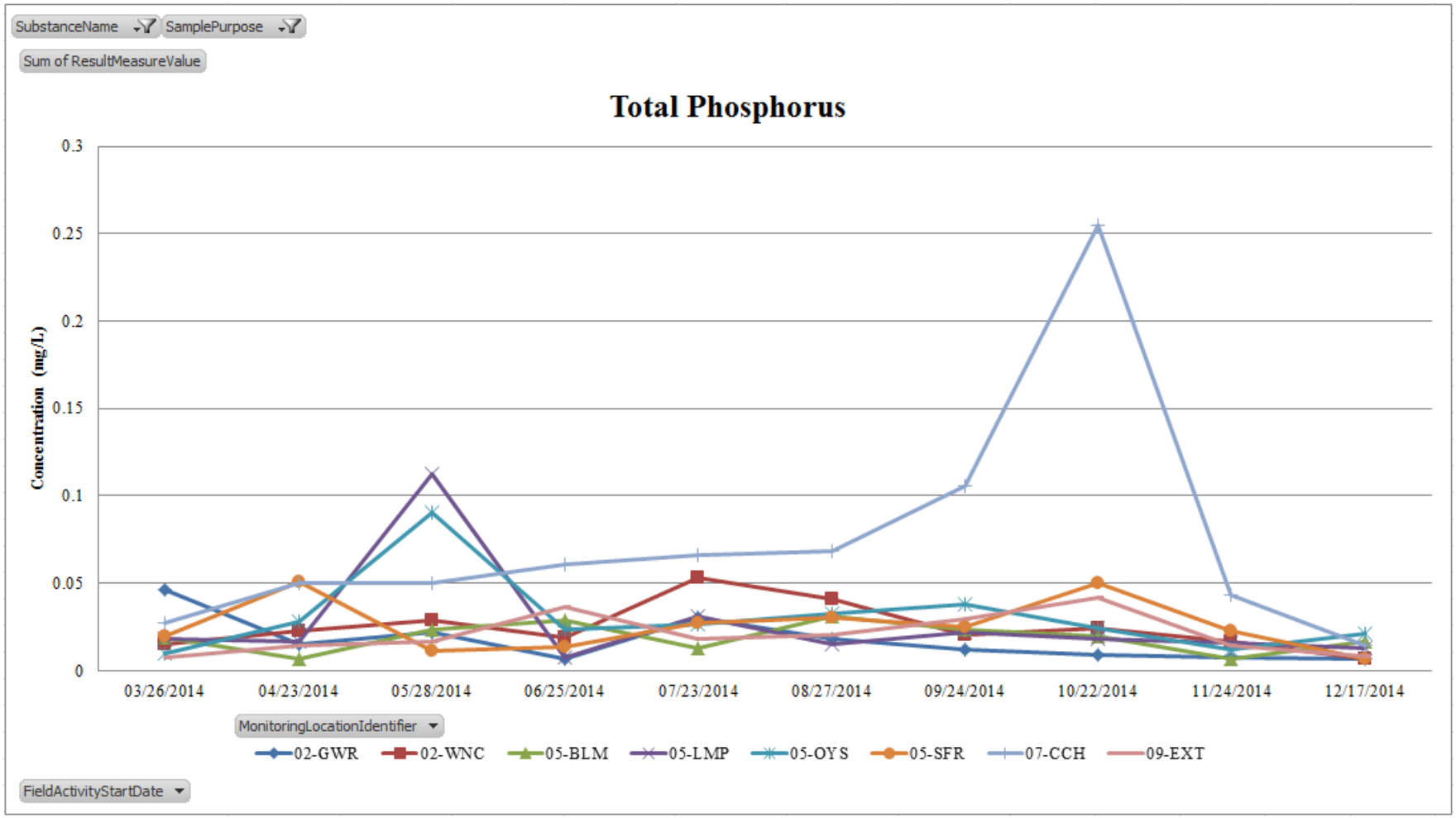

Figure 4: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations

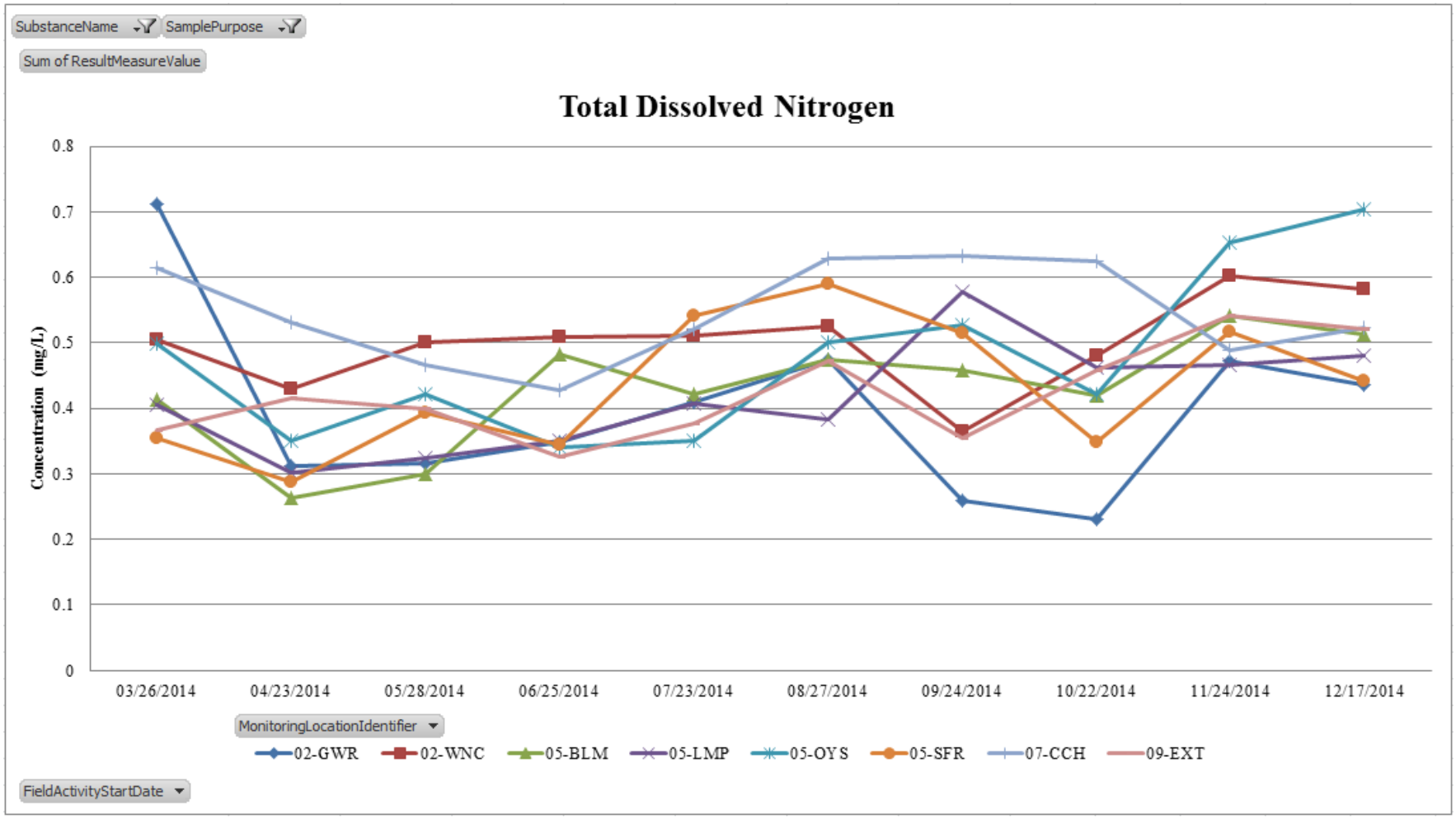

Figure 5: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations

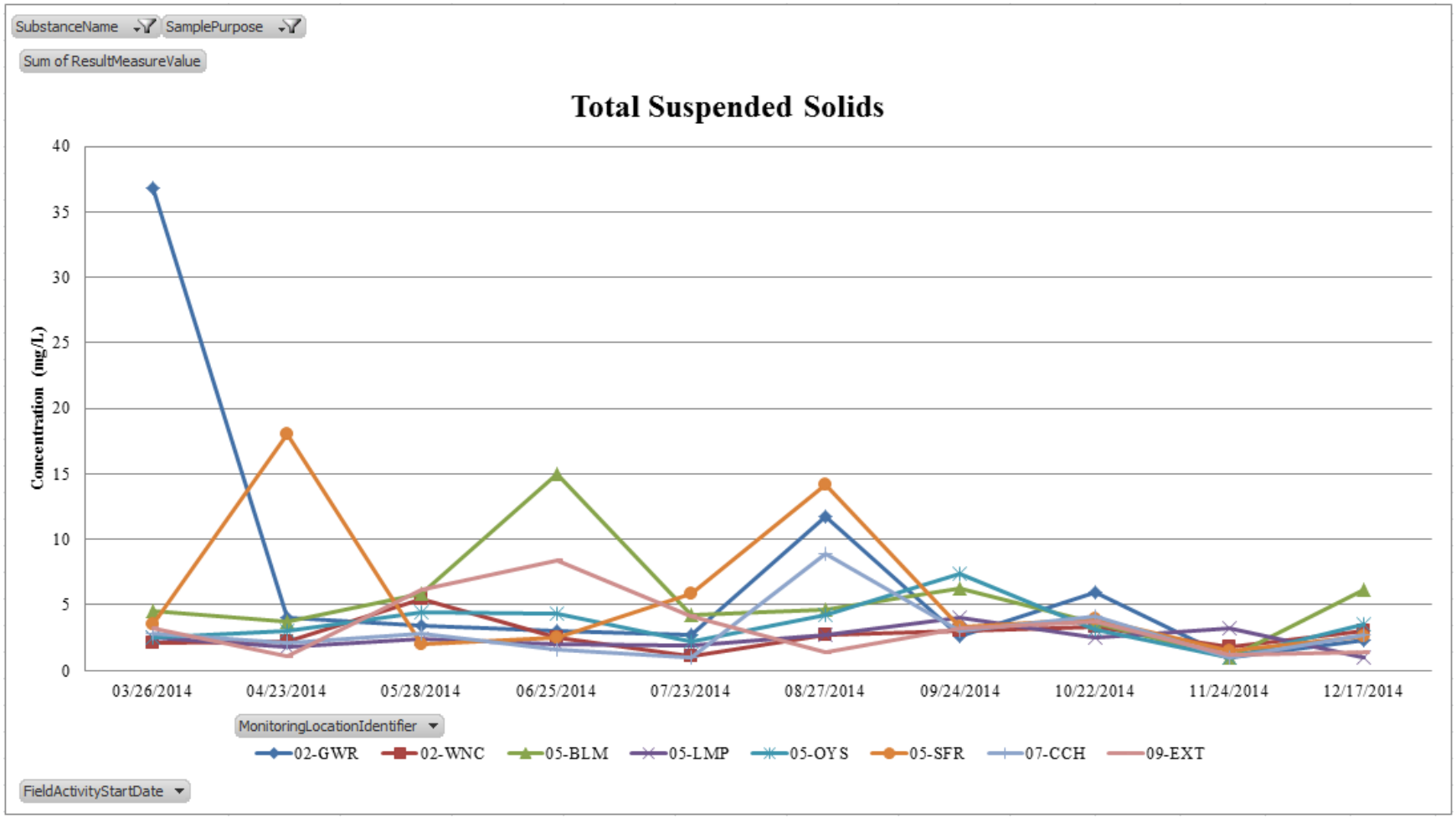

Figure 6: Nitrate/Nitrite Concentrations (in mg N/L) at Tributary Stations

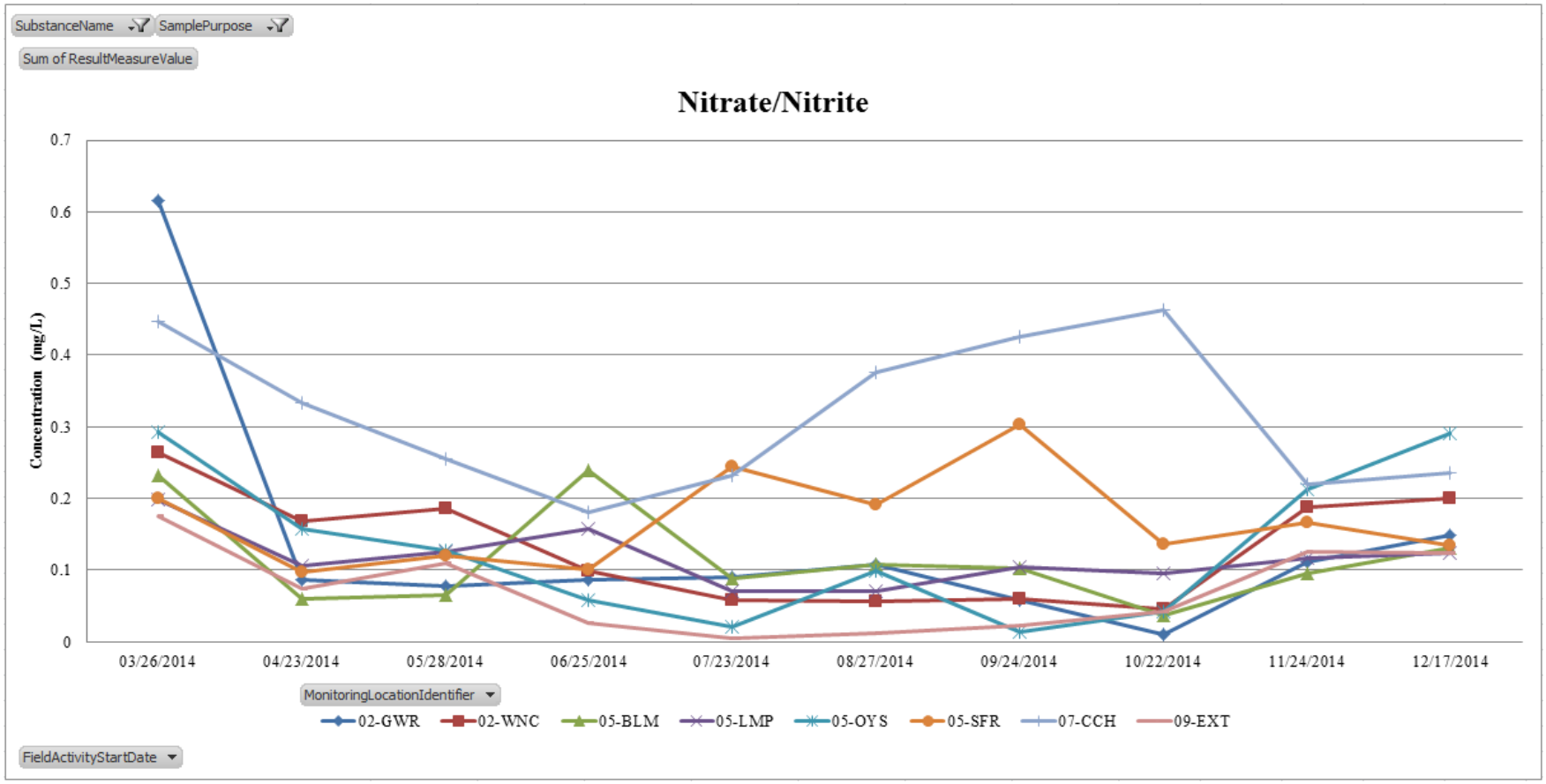

Figure 7: Ammonia Concentrations (in mg N/L) at Tributary Stations

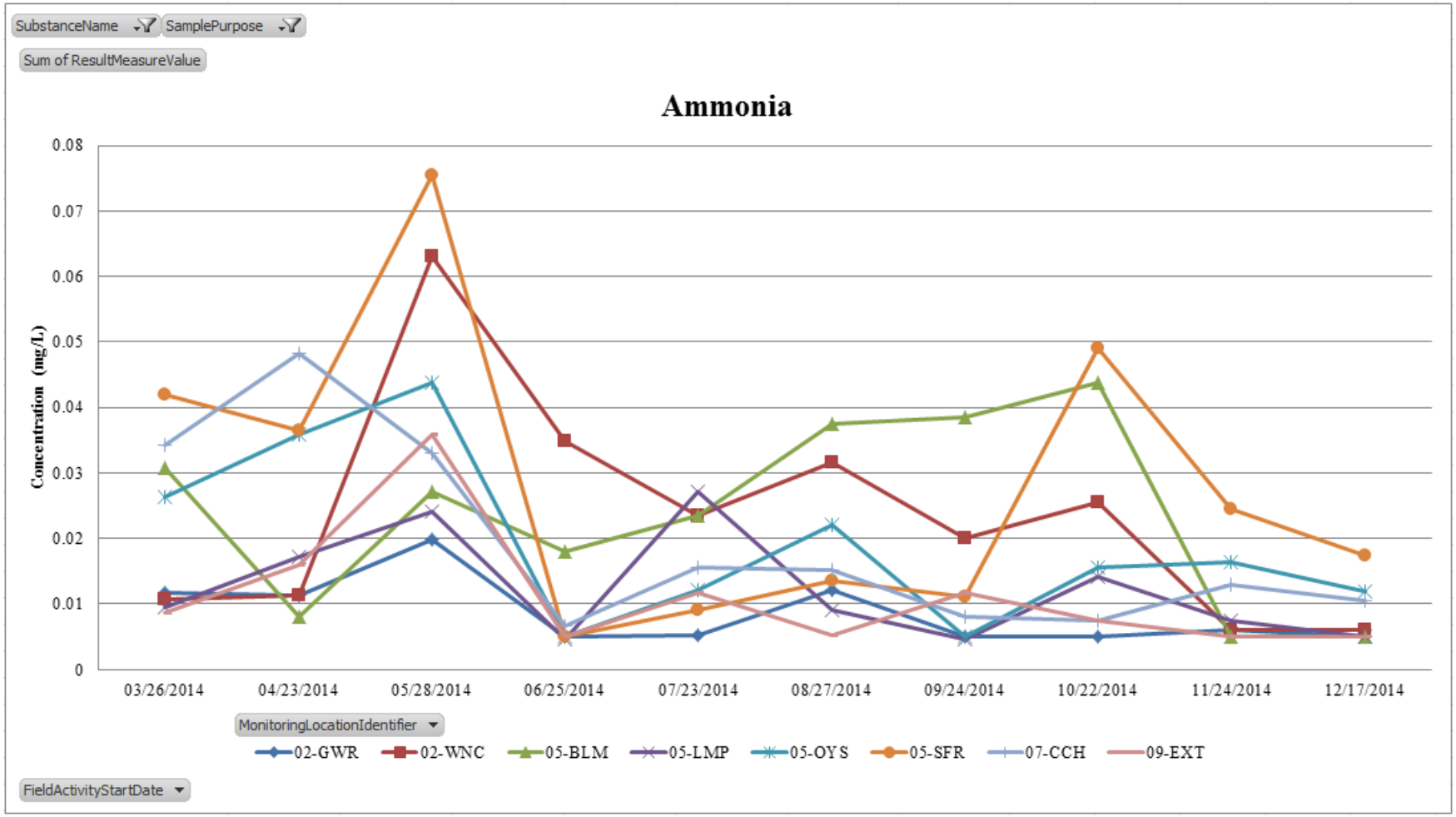

Figure 8: Dissolved Organic Nitrogen Concentrations (in mg N/L) at Tributary Stations

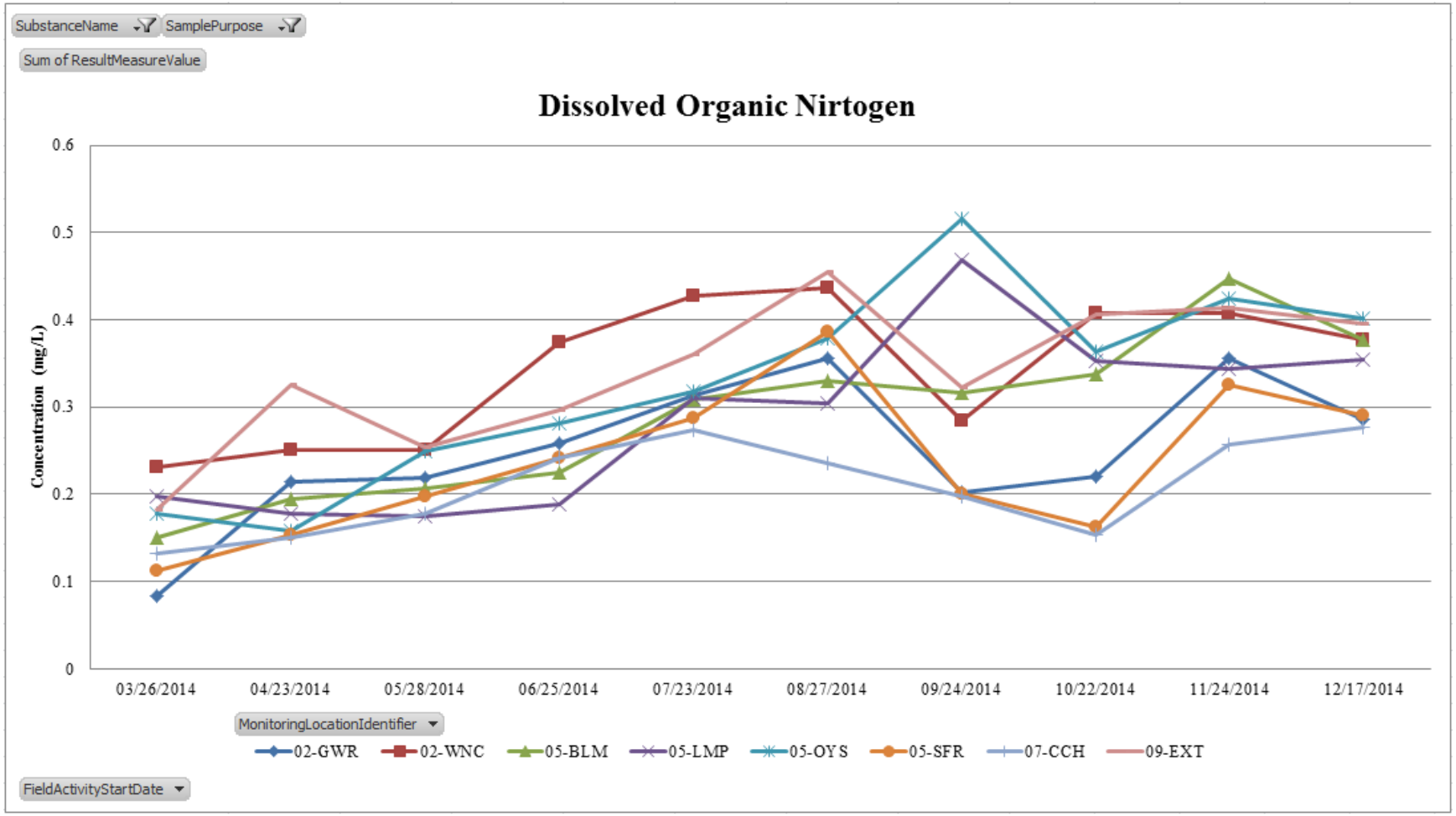

Figure 9: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations

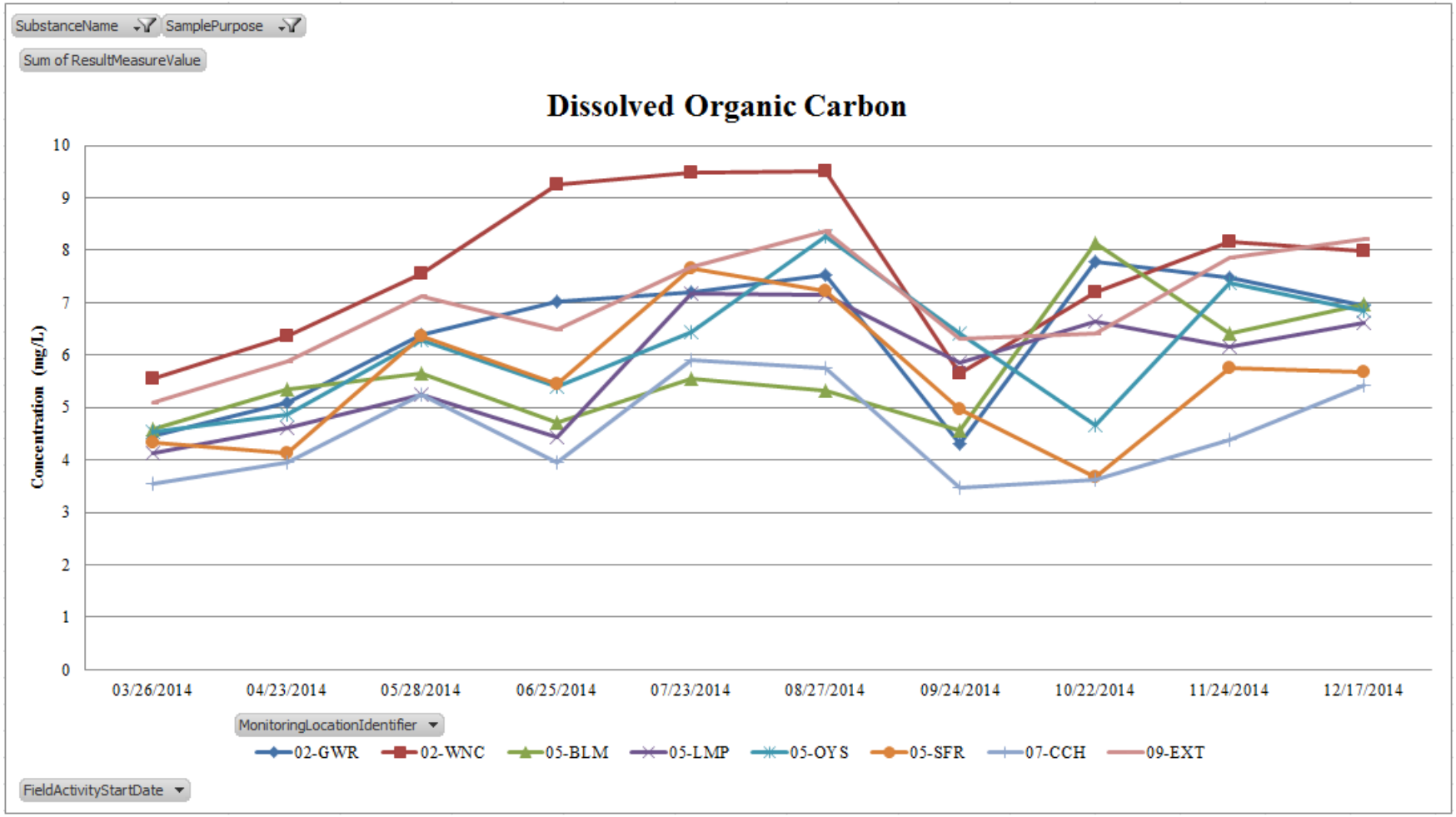

Figure 10: Total Suspended Nitrogen Concentrations (in mg N/L) at Tributary Stations

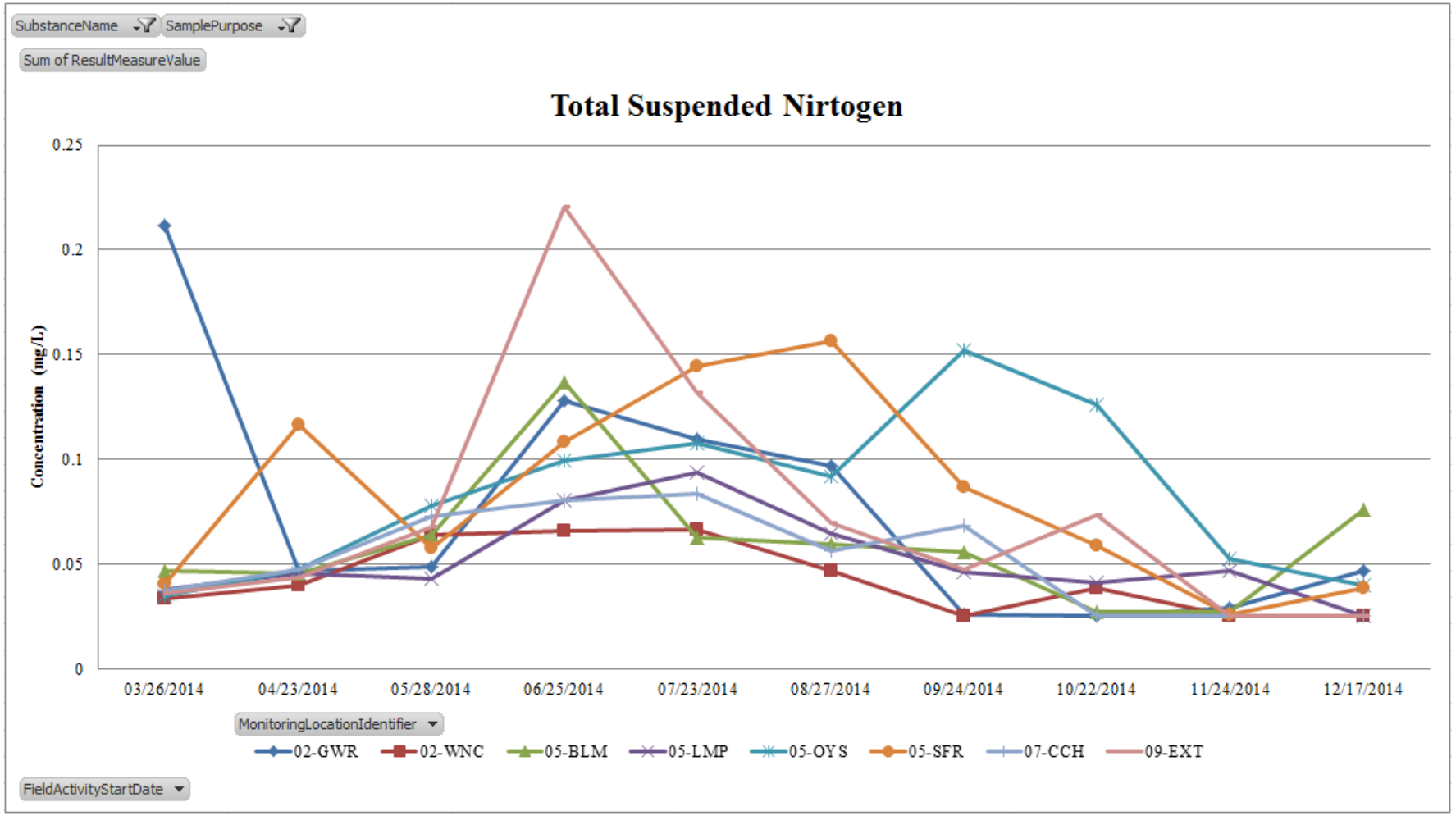

Figure 11: Orthophosphate Concentrations (in mg P/L) at Tributary Stations